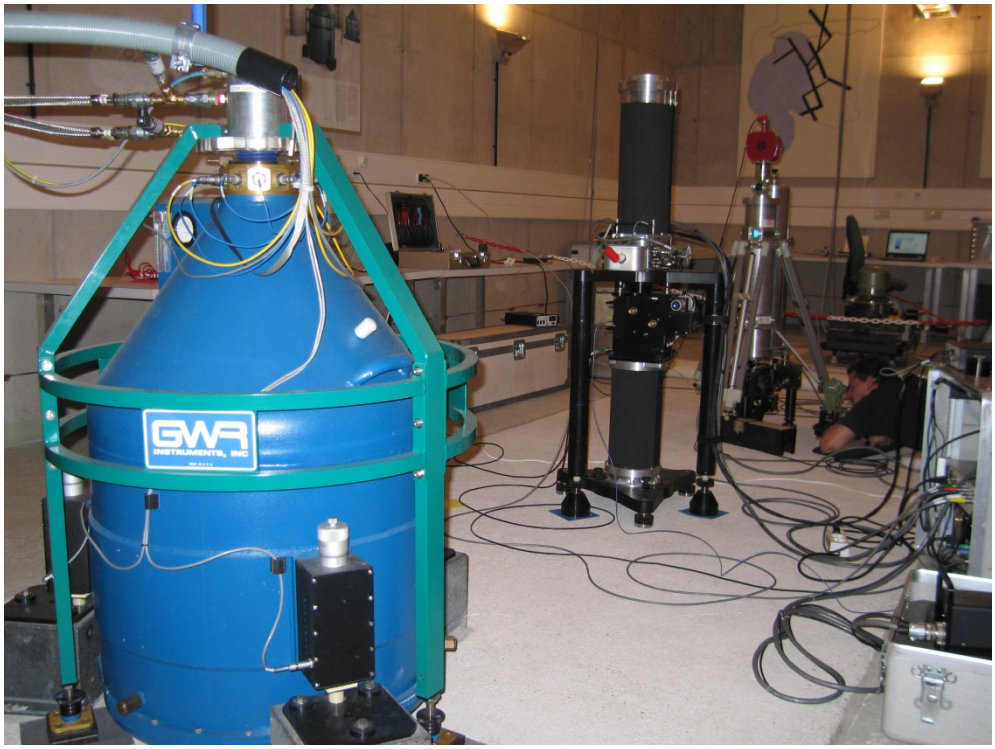

ABSOLUTE GRAVITY MEASUREMENTS AT THE CONRAD OBSERVATORIUM IN AUSTRIA IN JUNE 2008

Final Report

September 2008

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Foreword

This report contains the results of absolute gravity measurements carried out at the Conrad Observatorium in Austria in August 2007. The absolute gravimeter FG5#216 from the European Center for Geodynamics and Seismology was operated by Olivier Francis and Gilbert Klein from the University of Luxembourg. The main objective of this experiment was to calibrate the superconducting gravimeter: the absolute gravimeter operated simultaneously side-by-side with the superconducting gravimeter on the same pillar for approximately 3,5 days. The comparison between the times series from both instruments allows us to determine the scale or calibration factor of the superconducting gravimeter. During the experiment, the absolute gravimeter Jilag-6 from the Federal Office of Metrology and Surveying (BEV) occupied a site on the same pillar (see Figure 1).

Figure 1. Picture showing from the front to the back the absolute gravimeters Jilag-6 and FG5#216 and the superconducting Gravimeter on the same pillar.

In addition to the calibration of the superconducting gravimeter, a new absolute gravity site has been established next to the SG. The vertical gravity gradients and the gravity ties between the different sites were measured by Bruno Meurers with a Scintrex CG5.

We would like to thank Bruno Meurers and Norbert Blaumoser for their warm hospitality and help during our measurements.

This absolute gravity measurements campaign was funded by the University of Luxembourg.

Data processing

Raw data from the absolute gravimeters consist of vectors of time and position of the falling object during the drops. To obtain the gravity value, a linear equation representing the equation of motion is fit to the raw data including the gravity gradient which has been measured with relative meters.

The data processing follows the protocol adopted during absolute gravimeters comparisons at the BIPM in Sèvres (Francis and van Dam, 2003). Geophysical corrections are applied to the raw gravity data: Earth tides using modeled tidal parameters, atmospheric pressure effect using a constant admittance, and the polar motion effect using pole positions from IERS.

The g-soft version 7.0 software from Microg-LaCoste Inc. was used for the processing. All the text outputs as well as some figures are compiled in the annexes of this report for future reference.

Vertical Gravity Gradient

The vertical gravity gradient is needed to linearize the equation of motion but also to transfer the measured absolute gravity value from the reference height around 1.3 m to the floor. Bruno Meurers measured the vertical gravity gradient with his Scintrex CG5. He obtained a value –2.710 microGal/cm that we used to process the absolute gravity observations.

Results of the absolute gravity measurements

The FG5#216 operated from Sunday 1st of June 2008 at 18:30 until Thursday 5th of June 2008 at 05:00. A total of 82 sets of 100 drops every 5 seconds were taken with a rate of 2 set per hour. It represents a total of 8200 drops. Sets 17 and 18 were excluded from the final data processing due to anomalous high noise level.

Site	Gravity value /microgal	Set Standard Deviation /microgal
FG5#216 Absolute site @ 1.3 m	**980 647 605.21**	**0.82**

Reference

Francis O., van Dam T.M., Processing of the Absolute data of the ICAG01, Cahiers du Centre Européen de Géodynamique et de Séismologie, vol.22, 45-48, 2003.

ANNEXES

STATION: CONRAD OBSERVATORIUM			
City:	PERNITZ	Country:	Austria
Location:	Conrad Observatorium	Particularity:	
Situation:	Gravity Room	Remarks:	Site next to the superconducting gravimeter
Date:	01-05 June 2008		

Code number:	
Latitude:	47.92876 degrees
Longitude:	15.86090 degrees
Elevation:	1045.0 m
Gradient:	-2.710 μgal/cm
Reference height:	0. 1280 m + 1.1652 m = 1.2932m
Meter:	FG5
S/N:	216

Tidal corrections using observed tidal parameters

Polar motion correction			**Air pressure correction**	
X-coordinate	0.1290	Arc seconds	Nominal air pressure:	983.85 mbar
Y-coordinate	0.5375	Arc seconds	Barometric admittance factor:	0.3 μgal/mbar

Gravity

Set gravity mean:	**980 647 605.21**	microgal
Set std. dev.:	0.82	microgal
Mean std. dev.:	4.60	microgal
Number of sets:	80	
Number of drops per set:	100	
Drop interval:	10 seconds	
Set interval:	30 minutes	
Nominal/datum height:	1.30 m	

Author: O. Francis — University of Luxembourg

Date: September 21, 2008

Project file

Micro-g Solutions g Processing Report
File Created: 10/14/08, 15:45:06

Project Name: CO20080601
g Acquisition Version: 1.082300
g Processing Version: 7.070307

Company/Institution: University of Luxembourg
Operator: Olivier Francis and Gilbert Klein

Station Data
Name: Conrad Observatorium
Site Code: next to SG
Lat: 47.92876 Long: 15.86090 Elev: 1045.00 m
Setup Height: 12.80 cm
Transfer Height: 130.00 cm
Actual Height: 129.32 cm
Gradient: -2.710 µGal/cm
Nominal Air Pressure: 893.85 mBar
Barometric Admittance Factor: 0.30
Polar Motion Coord: 0.1290 " 0.5375 "
Earth Tide (ETGTAB) Selected
Potential Filename: C:\Program Files\Micro-g Solutions Inc\gWavefiles\Etcpot.dat
Delta Factor Filename: G:\ABSOLU\DATA\INI\OceanLoad-Conrad Observatorium.dff
Delta Factors

Start	Stop	Amplitude	Phase	Term
0.000000	0.002427	1.000000	0.0000	DC
0.002428	0.249951	1.160000	0.0000	Long
0.721500	0.906315	1.154250	0.0000	Q1
0.921941	0.974188	1.154240	0.0000	O1
0.989049	0.998028	1.149150	0.0000	P1
0.999853	1.216397	1.134890	0.0000	K1
1.719381	1.906462	1.161720	0.0000	N2
1.923766	1.976926	1.161720	0.0000	M2
1.991787	2.002885	1.161720	0.0000	S2
2.003032	2.182843	1.161720	0.0000	K2
2.753244	3.081254	1.07338	0.0000	M3
3.791964	3.937897	1.03900	0.0000	M4

Ocean Load ON, Filename: G:\ABSOLU\DATA\INI\OceanLoad-Conrad Observatorium.olf

Waves:	M2	S2	K1	O1	N2	P1	K2	Q1	Mf	Mm	Ssa
Amplitude (µGal):	1.110	0.365	0.096	0.129	0.224	0.035	0.095	0.034	0.000	0.000	0.000
Phase (deg):	45.6	17.9	73.7	161.2	62.5	86.7	15.0	-146.8	0.0	0.0	0.0

Instrument Data
Meter Type: FG5
Meter S/N: 216
Factory Height: 116.52 cm
Rubidium Frequency: 10000000.00970 Hz
Laser: WEO100 (187)
ID: 632.99117754 nm (0.65 V)
IE: 632.99119473 nm (0.19 V)
IF: 632.99121259 nm (-0.20 V)
IG: 632.99123023 nm (-0.43 V)
IH: 632.99136890 nm (-1.88 V)
II: 632.99139822 nm (-1.58 V)
IJ: 632.99142704 nm (-1.30 V)
Modulation Frequency: 8333.420 Hz

Processing Results
Date: 06/03/08
Time: 12:44:14
DOY: 155
Year: 2008
Time Offset (D h:m:s): 0 0:0:0
Gravity: 980647605.21 µGal
Set Scatter: 0.82 µGal
Measurement Precision: 0.09 µGal
Total Uncertainty: 0.09 µGal
Number of Sets Collected: 82
Number of Sets Processed: 80
Set #s Processed:
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,
41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,7
5,76,77,78,79,80,81,82
Number of Sets NOT Processed: 2
Set #s NOT Processed: 17,18
Number of Drops/Set: 100
Total Drops Accepted: 7931
Total Drops Rejected: 69
Total Fringes Acquired: 700
Fringe Start: 7
Processed Fringes: 613
GuideCard Multiplex: 4
GuideCard Scale Factor: 250

Acquisition Settings
Set Interval: 60 min
Drop Interval: 10 sec
Number of Sets: 100
Number of Drops: 100

Gravity Corrections
Earth Tide (ETGTAB): -22.45 µGal
Ocean Load: 0.01 µGal
Polar Motion: 0.43 µGal
Barometric Pressure: 0.53 µGal
Transfer Height: -1.84 µGal
Reference Xo: -0.82 µGal

Uncertainties
Sigma Reject: 3.00
Earth Tide Factor: 0.000
Average Earth Tide Uncertainty: 0.00 µGal
Ocean Load Factor: 0.00
Average Ocean Load Uncertainty: 0.00 µGal
Barometric: 0.00 µGal
Polar Motion: 0.00 µGal
Laser: 0.00 µGal
Clock: 0.00 µGal
System Type: 0.00 µGal
Tidal Swell: 0.00 µGal
Water Table: 0.00 µGal
Unmodeled: 0.00 µGal
System Setup: 0.00 µGal
Gradient: 0.00 µGal (0.00 µGal/cm)

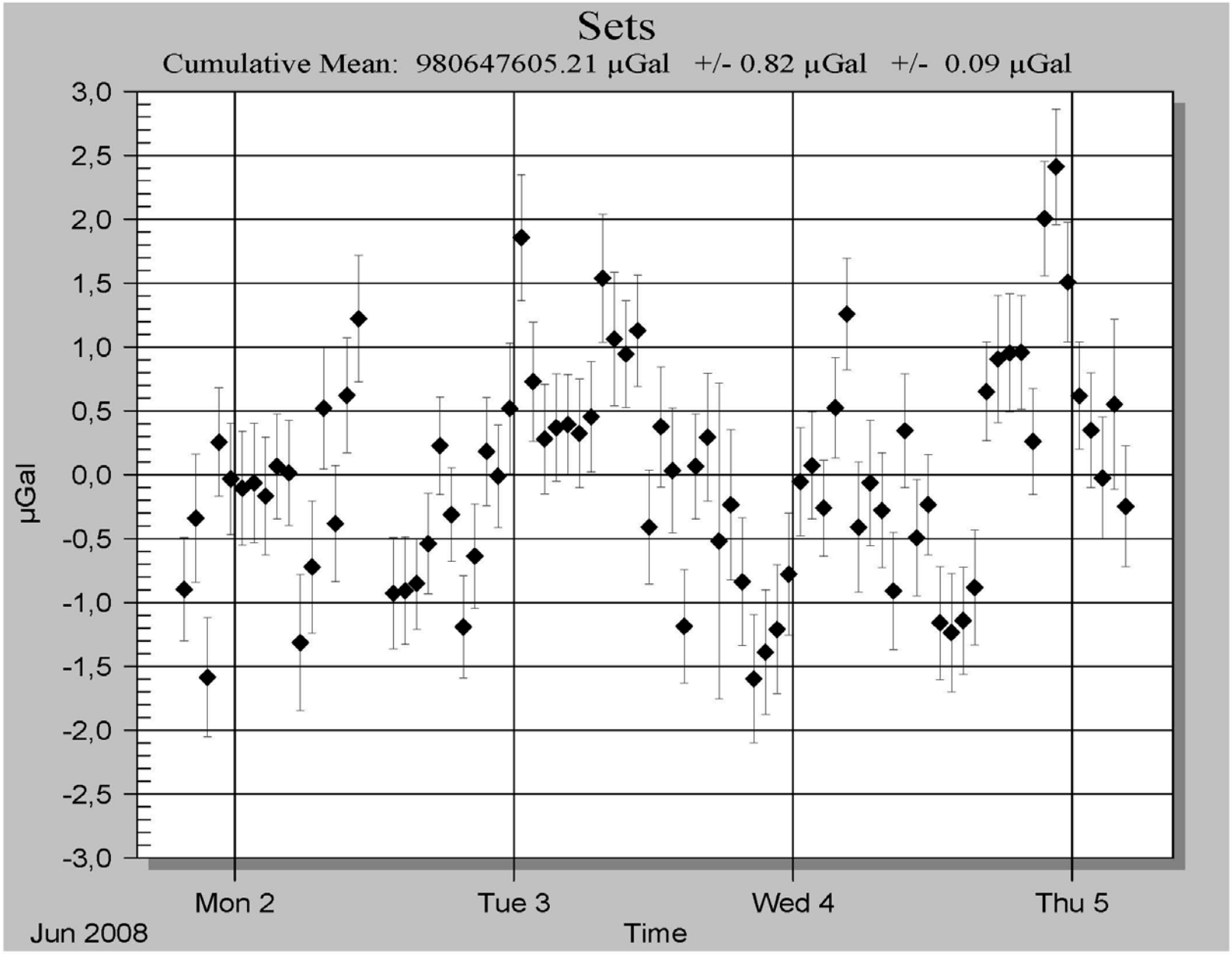
Set File

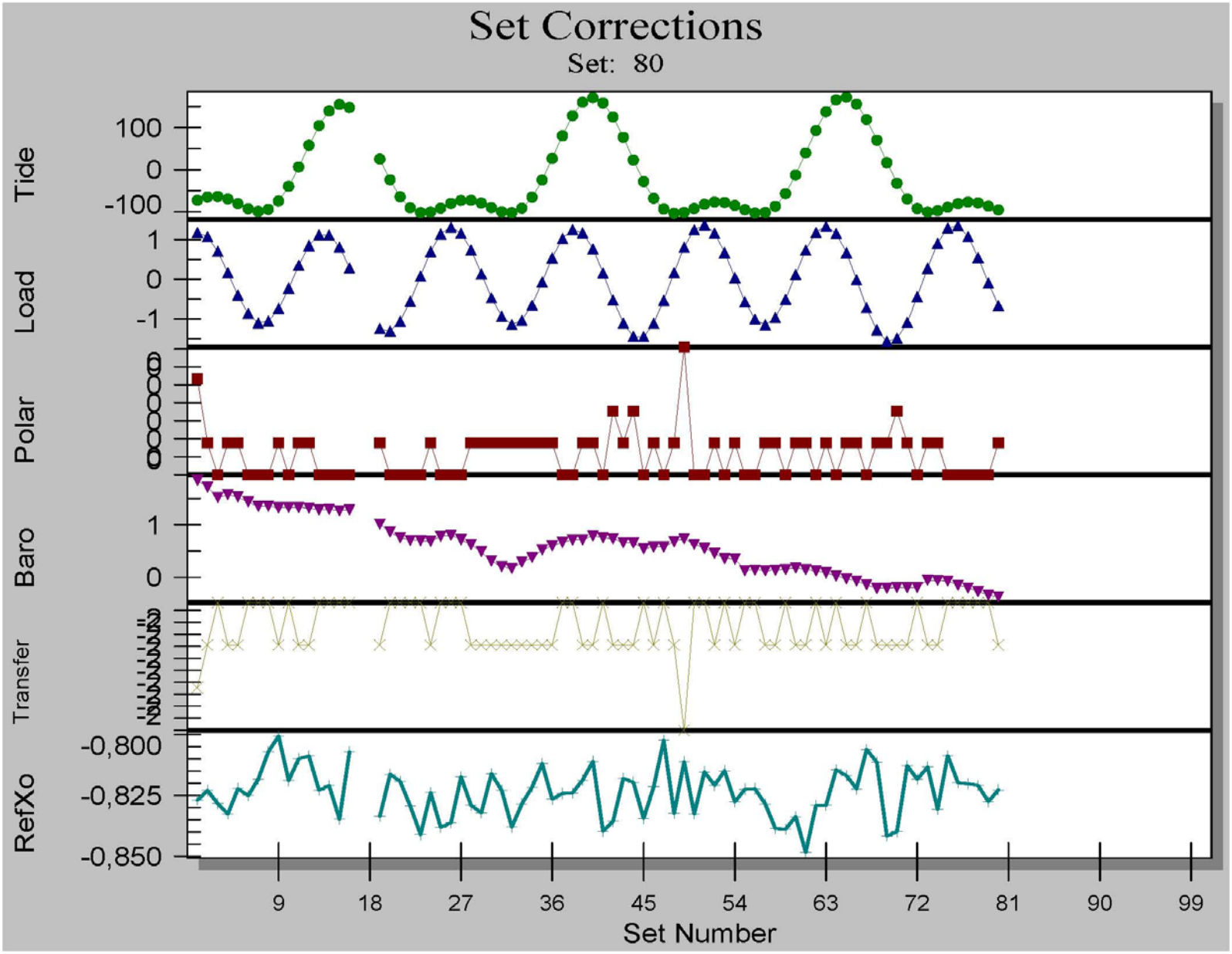
Source Data Filename: CO20080601
g Acquisition Version: 1.082300
g Processing Version: 7.070307

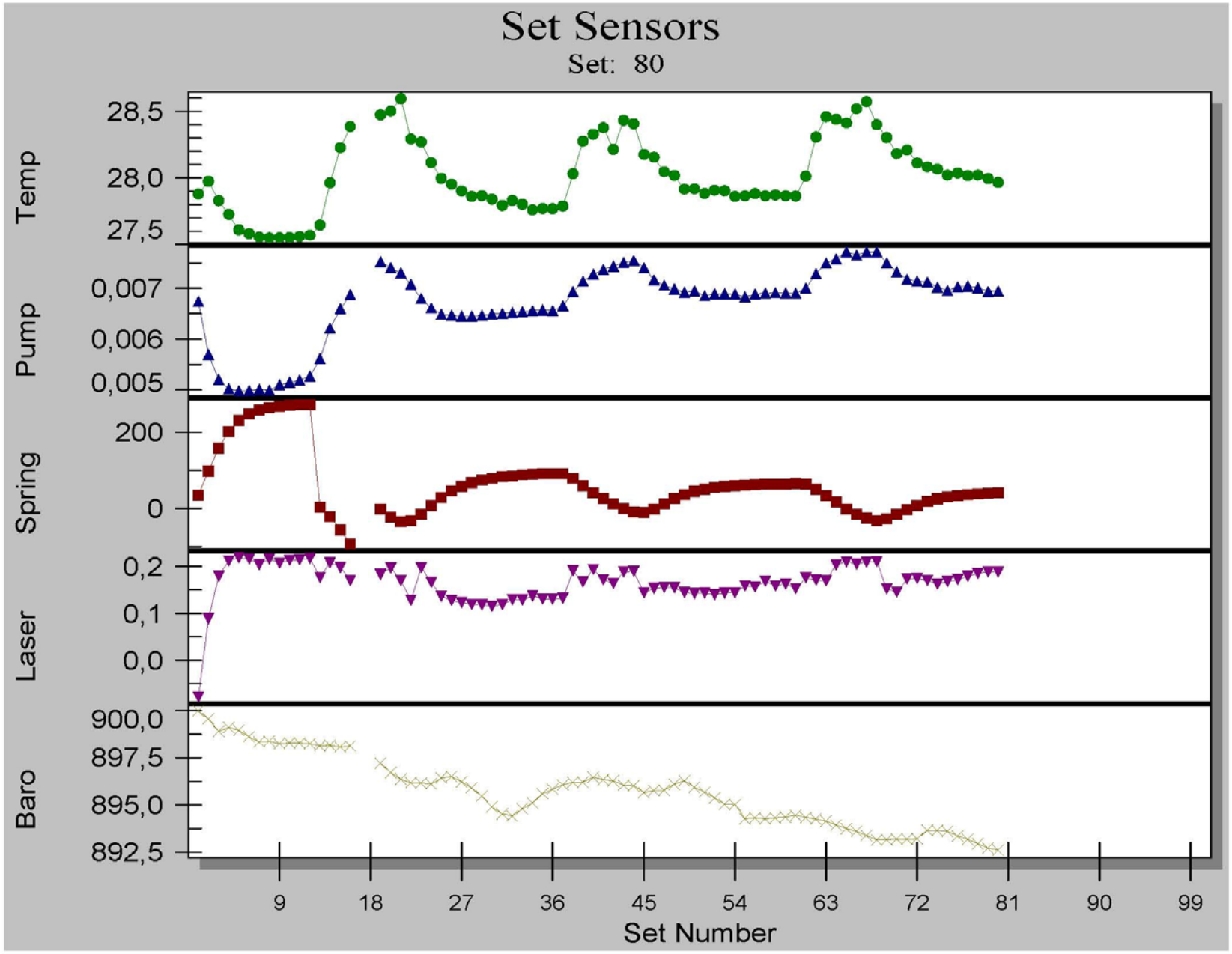
Set	Time	DOY	Year	Gravity	Sigma	Error	Uncert	Tide	Load	Baro	Polar	Transfer	Refxo	Temp	Pres	Accep	Reject
1	19:38:12	153	2008	980647604.313	3.965	0.407	0.407	-72.406	1.179	1.841	0.433	-1.843	-0.827	27.879	899.986	95	5
2	20:38:09	153	2008	980647604.870	4.968	0.502	0.502	-64.500	1.072	1.717	0.433	-1.843	-0.823	27.973	899.572	98	2
3	21:38:15	153	2008	980647603.624	4.656	0.466	0.466	-63.193	0.706	1.517	0.433	-1.843	-0.828	27.829	898.907	100	0
4	22:38:15	153	2008	980647605.464	4.230	0.425	0.425	-69.316	0.171	1.576	0.433	-1.843	-0.833	27.726	899.103	99	1
5	23:38:11	153	2008	980647605.177	4.343	0.437	0.437	-80.636	-0.399	1.532	0.433	-1.843	-0.822	27.609	898.956	99	1
6	00:38:15	154	2008	980647605.105	4.454	0.445	0.445	-92.474	-0.863	1.433	0.433	-1.843	-0.825	27.581	898.626	100	0
7	01:38:15	154	2008	980647605.146	4.689	0.469	0.469	-98.774	-1.102	1.349	0.433	-1.843	-0.818	27.557	898.347	100	0
8	02:38:15	154	2008	980647605.043	4.630	0.463	0.463	-93.905	-1.057	1.356	0.433	-1.843	-0.807	27.551	898.370	100	0
9	03:38:13	154	2008	980647605.276	4.100	0.412	0.412	-74.281	-0.738	1.321	0.433	-1.843	-0.801	27.552	898.253	99	1
10	04:38:15	154	2008	980647605.225	4.119	0.412	0.412	-39.551	-0.225	1.329	0.433	-1.843	-0.819	27.553	898.282	100	0
11	05:38:21	154	2008	980647603.895	5.265	0.532	0.532	6.815	0.351	1.331	0.433	-1.843	-0.810	27.560	898.285	98	2
12	06:38:14	154	2008	980647604.486	5.172	0.520	0.520	57.786	0.841	1.318	0.433	-1.843	-0.809	27.570	898.244	99	1
13	07:38:15	154	2008	980647605.730	4.762	0.476	0.476	104.894	1.119	1.284	0.433	-1.843	-0.823	27.647	898.129	100	0
14	08:38:15	154	2008	980647604.828	4.558	0.456	0.456	139.328	1.109	1.295	0.433	-1.843	-0.821	27.962	898.165	100	0
15	09:38:15	154	2008	980647605.831	4.510	0.451	0.451	154.475	0.807	1.266	0.433	-1.843	-0.835	28.228	898.069	100	0
16	10:38:15	154	2008	980647606.431	4.952	0.495	0.495	147.372	0.285	1.285	0.433	-1.843	-0.807	28.386	898.134	100	0
19	13:38:17	154	2008	980647604.282	4.320	0.434	0.434	25.243	-1.244	1.011	0.433	-1.843	-0.834	28.474	897.220	99	1
20	14:38:15	154	2008	980647604.302	4.199	0.420	0.420	-24.003	-1.308	0.864	0.433	-1.843	-0.816	28.503	896.730	100	0
21	15:38:15	154	2008	980647604.359	3.568	0.357	0.357	-64.178	-1.061	0.756	0.433	-1.843	-0.819	28.594	896.371	100	0
22	16:38:15	154	2008	980647604.670	3.942	0.394	0.394	-90.457	-0.559	0.701	0.433	-1.843	-0.829	28.291	896.187	100	0
23	17:38:15	154	2008	980647605.437	3.804	0.380	0.380	-101.682	0.078	0.694	0.433	-1.843	-0.841	28.269	896.165	100	0
24	18:38:13	154	2008	980647604.897	3.645	0.366	0.366	-100.231	0.694	0.684	0.433	-1.843	-0.824	28.114	896.131	99	1
25	19:38:15	154	2008	980647604.018	3.997	0.400	0.400	-91.044	1.140	0.778	0.433	-1.843	-0.838	27.996	896.443	100	0
26	20:38:15	154	2008	980647604.574	4.096	0.410	0.410	-80.139	1.307	0.799	0.433	-1.843	-0.836	27.953	896.513	100	0
27	21:38:15	154	2008	980647605.392	4.212	0.421	0.421	-72.863	1.157	0.718	0.433	-1.843	-0.817	27.902	896.242	100	0
28	22:38:10	154	2008	980647605.199	3.994	0.401	0.401	-72.425	0.731	0.620	0.433	-1.843	-0.829	27.860	895.915	99	1
29	23:38:11	154	2008	980647605.729	5.089	0.511	0.511	-79.027	0.137	0.488	0.433	-1.843	-0.832	27.866	895.476	99	1
30	00:38:14	155	2008	980647607.067	4.891	0.494	0.494	-89.771	-0.472	0.313	0.433	-1.843	-0.816	27.840	894.893	98	2
31	01:38:16	155	2008	980647605.939	4.645	0.467	0.467	-99.381	-0.939	0.202	0.433	-1.843	-0.823	27.794	894.524	99	1
32	02:38:14	155	2008	980647605.490	4.270	0.429	0.429	-101.665	-1.147	0.169	0.433	-1.843	-0.838	27.831	894.412	99	1
33	03:38:13	155	2008	980647605.579	4.191	0.421	0.421	-91.272	-1.042	0.286	0.433	-1.843	-0.829	27.802	894.803	99	1
34	04:38:14	155	2008	980647605.604	3.915	0.393	0.393	-65.293	-0.651	0.377	0.433	-1.843	-0.822	27.761	895.107	99	1

35	05:38:13	155	2008	980647605.534	4.207	0.423	0.423	-24.457	-0.076	0.527	0.433	-1.843	-0.812	27.771	895.605	99	1
36	06:38:11	155	2008	980647605.663	4.278	0.430	0.430	26.695	0.535	0.598	0.433	-1.843	-0.827	27.769	895.845	99	1
37	07:38:15	155	2008	980647606.748	5.012	0.501	0.501	80.600	1.022	0.664	0.433	-1.843	-0.824	27.790	896.063	100	0
38	08:38:15	155	2008	980647606.272	5.235	0.524	0.524	127.928	1.254	0.709	0.433	-1.843	-0.824	28.031	896.213	100	0
39	09:38:14	155	2008	980647606.154	4.126	0.417	0.417	160.069	1.164	0.711	0.433	-1.843	-0.819	28.277	896.221	98	2
40	10:38:13	155	2008	980647606.338	4.325	0.437	0.437	170.941	0.766	0.786	0.433	-1.843	-0.811	28.329	896.469	98	2
41	11:38:15	155	2008	980647604.800	4.459	0.446	0.446	158.445	0.153	0.751	0.433	-1.843	-0.840	28.378	896.352	100	0
42	12:38:10	155	2008	980647605.586	4.644	0.472	0.472	125.073	-0.525	0.729	0.433	-1.843	-0.836	28.214	896.281	97	3
43	13:38:06	155	2008	980647605.242	4.829	0.488	0.488	77.095	-1.105	0.659	0.433	-1.843	-0.818	28.433	896.048	98	2
44	14:38:09	155	2008	980647604.024	4.397	0.446	0.446	23.125	-1.441	0.653	0.433	-1.843	-0.820	28.407	896.026	97	3
45	15:38:15	155	2008	980647605.276	4.124	0.412	0.412	-27.724	-1.446	0.543	0.433	-1.843	-0.834	28.175	895.661	100	0
46	16:38:13	155	2008	980647605.504	4.947	0.500	0.500	-67.880	-1.118	0.576	0.433	-1.843	-0.822	28.156	895.772	98	2
47	17:38:15	155	2008	980647604.690	12.359	1.236	1.236	-93.248	-0.534	0.581	0.433	-1.843	-0.802	28.046	895.786	100	0
48	18:38:17	155	2008	980647604.975	5.857	0.589	0.589	-103.322	0.165	0.676	0.433	-1.843	-0.832	28.017	896.104	99	1
49	19:37:50	155	2008	980647604.372	4.801	0.501	0.501	-101.194	0.805	0.732	0.433	-1.843	-0.811	27.916	896.289	92	8
50	20:38:15	155	2008	980647603.611	5.023	0.502	0.502	-92.088	1.244	0.625	0.433	-1.843	-0.833	27.918	895.933	100	0
51	21:38:15	155	2008	980647603.821	4.910	0.491	0.491	-82.189	1.368	0.549	0.433	-1.843	-0.815	27.883	895.679	100	0
52	22:38:20	155	2008	980647603.999	5.026	0.505	0.505	-76.457	1.156	0.454	0.433	-1.843	-0.821	27.907	895.364	99	1
53	23:38:15	155	2008	980647604.431	4.784	0.478	0.478	-77.509	0.671	0.355	0.433	-1.843	-0.815	27.903	895.033	100	0
54	00:38:12	156	2008	980647605.156	4.216	0.424	0.424	-84.826	0.041	0.348	0.433	-1.843	-0.828	27.860	895.012	99	1
55	01:38:15	156	2008	980647605.282	4.184	0.418	0.418	-94.972	-0.571	0.127	0.433	-1.843	-0.823	27.864	894.274	100	0
56	02:38:15	156	2008	980647604.949	3.755	0.376	0.376	-102.440	-1.004	0.139	0.433	-1.843	-0.822	27.881	894.314	100	0
57	03:38:13	156	2008	980647605.734	3.921	0.394	0.394	-101.249	-1.148	0.128	0.433	-1.843	-0.829	27.865	894.276	99	1
58	04:38:17	156	2008	980647606.468	4.338	0.436	0.436	-86.609	-0.965	0.135	0.433	-1.843	-0.839	27.872	894.300	99	1
59	05:38:15	156	2008	980647604.799	5.085	0.508	0.508	-56.536	-0.504	0.152	0.433	-1.843	-0.839	27.864	894.355	100	0
60	06:38:09	156	2008	980647605.147	4.870	0.492	0.492	-12.683	0.115	0.178	0.433	-1.843	-0.834	27.862	894.444	98	2
61	07:38:13	156	2008	980647604.931	4.466	0.449	0.449	39.895	0.731	0.146	0.433	-1.843	-0.848	28.012	894.337	99	1
62	08:38:15	156	2008	980647604.299	4.585	0.458	0.458	93.052	1.179	0.120	0.433	-1.843	-0.829	28.308	894.250	100	0
63	09:38:15	156	2008	980647605.556	4.438	0.446	0.446	137.706	1.336	0.086	0.433	-1.843	-0.829	28.459	894.136	99	1
64	10:38:15	156	2008	980647604.717	4.582	0.458	0.458	165.812	1.153	0.024	0.433	-1.843	-0.815	28.441	893.929	100	0
65	11:38:20	156	2008	980647604.976	3.917	0.394	0.394	172.115	0.665	-0.028	0.433	-1.843	-0.817	28.413	893.756	99	1
66	12:38:16	156	2008	980647604.050	4.382	0.443	0.443	155.494	-0.012	-0.071	0.433	-1.843	-0.822	28.519	893.612	98	2
67	13:38:15	156	2008	980647603.973	4.633	0.463	0.463	119.197	-0.718	-0.142	0.433	-1.843	-0.806	28.573	893.377	100	0
68	14:38:15	156	2008	980647604.068	4.181	0.420	0.420	70.013	-1.280	-0.210	0.433	-1.843	-0.811	28.400	893.149	99	1
69	15:38:17	156	2008	980647604.327	4.474	0.450	0.450	16.687	-1.561	-0.206	0.433	-1.843	-0.842	28.304	893.163	99	1
70	16:38:11	156	2008	980647605.861	3.803	0.386	0.386	-31.933	-1.490	-0.194	0.433	-1.843	-0.840	28.182	893.202	97	3
71	17:38:11	156	2008	980647606.115	4.945	0.499	0.499	-69.329	-1.086	-0.197	0.433	-1.843	-0.813	28.210	893.194	98	2
72	18:38:15	156	2008	980647606.164	4.651	0.465	0.465	-91.990	-0.444	-0.191	0.433	-1.843	-0.818	28.112	893.212	100	0
73	19:38:11	156	2008	980647606.169	4.445	0.447	0.447	-100.137	0.276	-0.057	0.433	-1.843	-0.813	28.083	893.661	99	1

74	20:38:19	156	2008	980647605.470	4.126	0.415	0.415	-97.266	0.905	-0.060	0.433	-1.843	-0.831	28.066	893.650	99	1
75	21:38:15	156	2008	980647607.216	4.477	0.448	0.448	-88.797	1.290	-0.073	0.433	-1.843	-0.809	28.020	893.606	100	0
76	22:38:15	156	2008	980647607.620	4.521	0.452	0.452	-80.399	1.347	-0.151	0.433	-1.843	-0.820	28.036	893.348	100	0
77	23:38:15	156	2008	980647606.717	4.673	0.467	0.467	-76.444	1.072	-0.204	0.433	-1.843	-0.820	28.017	893.169	100	0
78	00:38:15	157	2008	980647605.829	4.187	0.419	0.419	-78.802	0.545	-0.274	0.433	-1.843	-0.821	28.020	892.937	100	0
79	01:38:15	157	2008	980647605.558	4.508	0.451	0.451	-86.373	-0.092	-0.343	0.433	-1.843	-0.828	27.995	892.708	100	0
80	02:38:11	157	2008	980647605.184	4.752	0.478	0.478	-95.417	-0.668	-0.369	0.433	-1.843	-0.823	27.965	892.620	99	1
81	03:38:15	157	2008	980647605.761	6.670	0.667	0.667	-100.633	-1.035	-0.395	0.433	-1.843	-0.812	27.985	892.532	100	0
82	04:38:15	157	2008	980647604.962	4.725	0.472	0.472	-96.578	-1.096	-0.351	0.433	-1.843	-0.814	27.989	892.679	100	0


Sets
Cumulative Mean: 980647605.21 µGal +/- 0.82 µGal +/- 0.09 µGal
3,0
2,5
2,0
1,5
1,0
0,5
0,0
-0,5
-1,0
-1,5
-2,0
-2,5
-3,0
µGal
Mon 2
Tue 3
Wed 4
Thu 5
Jun 2008
Time


Set Corrections
Set: 80
Tide
100
0
-100
Load
1
0
-1
Polar
Baro
1
0
Transfer
RefXo
-0,800
-0,825
-0,850
9
18
27
36
45
54
63
72
81
90
99
Set Number


Set Sensors
Set: 80
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28,0
27,5
Pump
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0,006
0,005
Spring
200
0
Laser
0,2
0,1
0,0
Baro
900,0
897,5
895,0
892,5
9
18
27
36
45
54
63
72
81
90
99
Set Number